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An experimental course in introductory psychology at Georgetown University utilizes principles of operant reinforcement to modify verbal behavior in the classroom situation. The major facet of the program is a student-student interview. Interviews are scheduled after each student reads a portion of the assigned text. One student, the listener, times and listens to the speaker without comment. When the speaker concludes, the listener, familiar with the material comments on the presentation. If both students are satisfied that the interview shows mastery of the text, results are recorded on a class chart. At the end of each chapter (three to five interviews), the student takes a written exercise. Student-instructor conferences are held after each written examination, and remedial procedures discussed if necessary. There was one lecture a week, and a final examination was given. Students progressed through the course at different rates, but the overall frequency of interviews increased as the course progressed. The interview, in addition to maintaining student activity in the class, also served to reinforce study behaviors which produced well verbalized interviews. Informal contact with the teaching staff also contributed to each student's identification with the course. (SK)

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INDIVIDUALIZED INSTRUCTION IN A LARGE INTRODUCTORY PSYCHOLOGY COLLEGE COURSE[1,2]

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This report describes an experiment which applies general principles of operant reinforcement to creating and maintaining new verbal behavior in the classroom. An application of these principles in a class of 79 students of the author's introductory psychology course at Georgetown University has led to an instructional program in which the student completes the course of study at his own pace, which is reactive to those study behaviors leading to fluent understanding of the subject matter and which guarantees mastery of one part of the syllabus before the student goes on to the next. The instructional procedures are similar in concept to those reported by Keller (1967 a,b; 1968 a,b) and Ferster and Perrott (1968).

Course Procedures

The primary procedure of the course is the interview which one student schedules with another after reading a part of the assigned text, usually ten to fifteen pages. The interview is a formal arrangement in which the

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[2]The present experiment grew out of pilot experiences during the training program of the Linwood Project (Ferster, 1967) and a course for a small number of graduate students at the College of Education of the University of Maryland. Subsequent to these experiments, the same procedure described here was used successfully by Dr. John J. Boren teaching the same course at the University of Maryland. Similar procedures are being used by the author in all of his courses at Georgetown University. Enrollment in the introductory course is planned for 120 students for the 1968-69 academic year.

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listener who has already read that part of the text uses a timer and listens to the speaker without interruptions. Both students refer to text or notes as they speak. After the speaker finishes talking, the listener comments on how the speaker covered the topic of the text, mentions important omissions, corrects inaccuracies of concept or language, or converses on some aspect of the subject matter. If both students are satisfied that the interview shows mastery of the text, they record the results on a class chart and the speaker finds another student to whom he speaks. If not, the speaker restudies the part and repeats the interview. Each student is required to listen once for each time he speaks. At the end of three to five sections (a chapter) the student takes a brief quiz to demonstrate his mastery of the course. There are five or six versions of each quiz, called written exercises to avoid the pejorative connotations of an examination. These are taken from essay study questions of which there are typically 10 or 15 for each Part or 60 for each Chapter. The study questions also give the students a rough guide as to the detail and penetration of study required. The written exercises are graded by the section assistant and if it is satisfactory, the student goes on to do interviews on the next chapter. If it is not satisfactory, a remedial procedure is discussed with the instructor or section assistant. There is a brief conference with a course assistant or instructor following each written exercise.

The student's grade is determined by how much of the course of study he completes. A grade of "C" required approximately three-fourths of the amount of study needed for an "A". Complete mastery, however, was required at any level for course credit. There were no penalties for review or

repetition of a written exercise. A student who failed to achieve mastery was given special help until the difficulty was diagnosed and mastery achieved. A final examination, a two-hour essay, taken from the hundreds of study questions which the student had used in his study of the text, served as a final check on the student's mastery and to formally certify the student for course credit to the registrar.

The course content was defined by 8 Chapters of Behavior Principles (Ferster and Perrott, 1968), a text describing general principles of operant reinforcement, articles covering a range of general topics in psychology from the Scientific American and chapters on Personality (Lundin, 1966), Measurement (Horowitz, 1966), and Child Development (Smith, 1966). The four-credit course met for an hour on each of four days. Later, at the students request, class time was extended for an additional hour on two of the class periods. One hour each week was designated for lecture and discussion but attendance was optional and students could do interviews and written exercises during lecture periods. Lecture periods were spent discussing topics of general interest to the students such as psychoanalysis, study procedures, psychotherapy, and child rearing problems. These discussions served as occasions to demonstrate the use of the experimental language about behavior which the student was learning.

The students were assigned to one of five sections (approximately 17 students in each) each led by an upperclass psychology major who had already been through the course. The course assistants kept the records of the students' progress through the course, scheduled interviews assigned, graded and discussed the results of written exercises, discussed problems and content

with students and kept the course instructor informed about the events in his section. The course instructor observed all of the class procedures, answered questions or discussed content with individual students and sought out students who were behind schedule or had special problems. The course assistants met with the instructor weekly to discuss special problems, exchange experiences and consider changes in course procedure.

The course met in a large lecture room with approximately 250 seats. The five sections of the room were identified by large placards suspended from the ceiling at the rear. The course assistants sat at tables in the front of the room or in one of the seats in the classroom. Students moved about the room freely and sat in neighboring seats to carry out interviews. Two students seated close together were not disturbed by the overall noise level of the room. If the noise level was unusually high they put their heads closer together. A nearby classroom, was available, however, as a quiet room in which students could study or take written exercises. Three to six students were seen daily in the quiet room. The noise level of the class, a continuous low hum, was not very difficult to overcome. Many of the students read and took written exercises right in the classroom.

Results

Of the 91 students who enrolled for the course 81 remained after two weeks, and 79 completed the course for credit; 90% with A's, 4% with B's and 6% with C's. The final examination, two hours long, and composed of short essay questions selected from the several hundred study questions which the student used in the study of the text, was intended to certify the student

for course credit. Although, the examination questions were very detailed, nearly all of the students answered them technically and in the same detail as in their original study. Only two people had unsatisfactory final examinations and both difficulties cleared up on retest.

Students went through the course at different rates. Thirty-six percent of the class finished the course including final examination three weeks before the end of the semester. Seventy-two percent of the class finished the course including the final examination before the last day of class.

Figure 1 shows the percentage of students doing one, two, or more than two interviews on each of the class days of the course. Taking the class on the average, the frequency of interviews (hence, study) increased as the course progressed. Figure 2 shows percentage of students absent from class during the semester. Although attendance ranged widely, the modal attendance was of the order of 60% or 70%. The daily cycle of absences was probably a result of the students' overall study schedule. The peak absences occurred on Fridays and the least absences on Tuesdays. Course attendance clearly reflected mid-term and other examinations in other classes. Figure 3 shows the frequency of those students who came to class but did not interview. These students may have read, listened to another student or carried out a written exercise. Except for the two days before and the one day after Christmas attendance rose substantially in the period following Thanksgiving compared with the first 30 class periods. Conversely, there was a decreased frequency of attendance at lectures and conversation with the course instructor during this period. The large number of people present but not speaking during the final session were taking the final examination.

Figure 4 contains records for six students who exemplify the range of individual performances that was encountered. Each curve, for an individual student, shows the cumulative number of interviews plotted by consecutive scheduled class periods. Fifty-nine interviews were required to complete the course. A student working at constant rate and finishing the course on the last day of the semester would produce a straight line beginning at origin and ending at the intersection of the 50th class period and the 59th interview. To conserve space and to make comparisons between the students easier, all of the curves are placed on the same coordinate by displacing them slightly in the vertical direction. The bottom record is that of a student who dropped the course. For the first month he attended class regularly but for the most part sat in the rear of the room reading. The course instructor had several conferences with him in which he appeared as a very depressed, anxious student who was having difficulties with all of his courses. The course instructor introduced him to several of his classmates who were at the same stage of the course as he, inquired of his progress weekly, and discussed study habits and methods with him. The rate of progress through the course increased as did his mood and level of social activity in class but his rate of progress was still not high enough to complete the course by the end of the semester without jeopardizing the rest of his courses which he possibly could pass by studying for the examinations. For this student there would have been merit in extending the course limit indefinitely. The experience of study leading to mastery and the successful completion of a course at the A-level might have been a significant experience for this student.

The second curve from the bottom is for a student who did very little during the first half of the semester, finishing the course with a sustained period of activity near the end. The open circles on the first part of the graph show that this student did most of his studying in class for the first part of the semester. When asked, during the 38th class period, about his performance, he replied that he was occupied with "other things" and that he would soon begin working on the course.

The third curve is for a student who decided to settle for a "C" or who increased his rate of work too late. The large number of classes which the student attended but did not interview suggests that he was doing little out of class study during most of the course.

The fourth curve is characteristic of most of the students. Progress is slow but steady until Christmas when the students hit a rate of work which completes the course approximately on the last day of classes. These students appear to be pacing themselves.

The top two curves are for two students who worked at a sustained pace from the start. The student represented in the top curve finished the course several weeks before the end of the semester. The student represented in the 5th curve was absent from class for several weeks just before the end of the semester, probably to study for another course.

When a written exercise given after a chapter did not show mastery, the section leader conversed with the student about the topics in the written exercise. If the student appeared to be competent orally he was allowed to go on, despite the incomplete or inaccurate written exercise, to the interviews of the next chapter. Since the student's deficiency was in written communication

rather than content, he was asked to do another exercise on the material he had just mastered orally to give him practice in writing. Most of the students quickly learned to do written exercises that matched the level of their oral fluency. Conversely those students whose written exercises did not show enough mastery of the course were also unable to speak competently in conversation about the content covered by the written exercise. With these students, the section leaders discussed the interview procedure, the student's study activity and asked that the interviews on the chapter in question be repeated. If the student continued to have difficulty in speaking accurately and fluently about the current chapter, the section leader or the course instructor listened to an interview and helped the student restudy (on the spot) those parts of the sections not adequately enunciated during the interview. For most students several experiences at this level developed the study behavior needed to speak fluently about the course content. For a few it was necessary to reduce the assignment to half sections (about 1200 to 1500 words) so as to give the student the experience of mastery after sustained intensive study behavior that it would have been impossible to complete the course within the semester. These students were also having great difficulty in completing assignments in their other courses.

Discussion

The interview is probably the experience in the course primarily responsible for the student's fluent active speaking repertoire. It provided an experience, closely following study activity, which exposed the new performances acquired as a result of study of the text. Because the student speaks

in detail about a small amount of text (approximately 3,000 words), there is a fine grain relationship between the student's interview performance and the study behavior that preceded. The speaking student is his own listener and reacts to subtle differences in the fluency, accuracy and depth of coverage of his presentation. This differential reactivity of the student to his own speech reinforces these subtle aspects of his study activity with the text which produce a competent vocal essay. Most students developed improved study skills which they extended to other courses. Besides providing subtle differential reinforcement of study behavior the interview also is a motivational device. The interview helps maintain the student's overall activity in the course because it exposes at frequent intervals his progress through the course. Many students reported that the speaking experience during the interviews increased their ability to express themselves elsewhere and improved their social ease.

The listener's role in the interview is mostly to make it possible for the speaker to speak since it is almost impossible for most people to speak alone. The listener cannot reinforce the speaker's behavior as subtly as the speaker himself since he is not nearly so reactive to the critical nuances of the speaker's behavior. Therefore, the decision about the adequacy of the interview came from the speaker rather than from the listener. Most students improved their style of study continuously as they noticed small deficiencies in their performance during the interview. When the quality of the interview did not improve over several chapters, some kind of remedial experience was used such as restudy or study methods. The student's perceptiveness about the nuances of his own performance was probably due in some part to the absence of penalties in the interview.

Just as the speaker is his own listener, the listener may be talking to himself as he listens. The listener is particularly able to take part in such a silent conversation because he has himself just been engaging in the same behavior as the speaker and hence could have as easily said the same things. Because of these latent verbal behaviors, verbal stimuli from the speaker can prompt verbal performances which would otherwise need to be composed and emitted. The listener, therefore, is free to combine verbal behaviors from a wide variety of past experiences with those prompted by the student who is speaking. Students often report that they combine behaviors from their common personal experience with the vocabulary and content of the interview in a way that would not have been likely otherwise.

It was important that the speaker not be interrupted during the interview lest the frequency and fluency of the speaker's behavior be progressively reduced. The speaker's behavior is weakened by interruptions because they are aversive or because they supply prompts which shift the control of the speaker's behavior away from the preceding study behavior with the text. The listener took written notes to remember the interview and commented freely after the interview refraining, however, from tutoring the speaker. Comments were consciously limited to attempts to strengthen, rearrange, recombine, or supplement behaviors already in the speaker's repertoire. Otherwise, the interaction would weaken the speaker's subsequent study behavior.

The Written Exercise

The written exercise given after each chapter was a conventional test rather than an exposure of the entire repertoire as in the interview. The tests, frequently they were given, provided only a sample of the student's

language from which the instructors could judge technical accuracy and fluency. The tests were used, therefore, as diagnostic information for certifying the student's progress through the course, and as a basis for suggesting remedial procedures. The written exercise only sampled the student's performance, it was not designed to reinforce the nuances of study behavior that are required for proper comprehension of the course content. There was not sufficient point to point correspondence between the study behavior and the written exercise to produce such a delicate result.

The conference with the student course assistant following the written exercise was the main point of personal contact with the student. These brief conferences with student assistants were effective because they were brief, frequent interactive experiences with an individual student and because the undergraduate instructor, recently a student himself, had a repertoire very close to that of the student. The interaction between the student and course instructor over the written exercise probably prevented a slow drift in the student's criterion of course mastery.

The Role of the Course Instructor

Much of the course instructor's work needed to be done before the course started. The student assistants had to be appointed and trained; texts needed to be selected that could generate mastery without rote memorization; the amount of text required of the student needed to be defined carefully because the student was required to master it all at high level of comprehension; study questions needed to be written for all of the texts and their frequency and thematic content designed to define the depth of penetration that was

expected of the students; criteria for grading needed to be established and procedures arranged for introducing the students to the course procedures; record forms and charts had to be prepared for taking data of the students' progress in the course, for a permanent record, and for display to the students.

Once the course began, the course instructor's time was used flexibly. Free time was needed to observe the class and to listen to selected interviews. Individual students approached the instructor in class with questions or for an opportunity to converse but most students were concerned largely with acquiring mastery and credit for the course through study, interviews and written exercises. Lectures were well attended at the start of the course, perhaps as a carry-over from students' past course experience and because of interest in the instructor's style. Attendance for lectures finally settled at 8-15 persons, usually those who were on schedule. It is probably best to schedule lectures and free discussion at a time that does not compete with course activities that bring the student toward completion of the course requirements.

Just as students who were making good progress through the course sought out the instructor in lecture, discussion and casual conversation, the course instructor sought out those students who were lagging or otherwise having difficulty. Discussions were held individually with these students to find out why progress through the course was slow, or to find the basis for other difficulties. When a particular problem was identified, the course instructor continued to monitor the student's behavior by direct observation and interviews, and by conversation with the section leader.

The Design of the Text

Although the basic operation of the course did not depend on any special textual material, almost half of the course was based on Behavior Principles, a textbook whose design came from a self-conscious application of principles of reinforcement. Behavior Principles was composed under close control of an actual reader, who carried out interviews based on a draft from part of the text. When it appeared that an incomplete interview was due to a defect in the text rather than student's study behavior, a tutorial was carried out which then served as a guide for rewriting or adding to the text. Often the tutorial provided the actual language for the text revisions. The behavior generated by the interview put the writer closely under the control of the reader since he had detailed evidence of the behavior that the text generated in the student. The division of the chapters into parts, topographically by headings and page separation and functionally by the study questions and interviews, had significant motivational effects. The smaller sub-units within chapters made the study experience more reactive than would be the case when the study unit is larger. Theoretically, each interview reinforced a small fixed-ratio schedule of reinforcement, and the successive interviews within a chapter were conditioned reinforcers leading to completion of the chapter.

Most of the study questions were in the form, "After reading this part, you should be able to . . . ." They were designed to instruct the student how to study each part of the text. At one stage of study, for example, a student would be expected to describe a reflex and an operant technically. At another stage the student might be expected to comment

theoretically about operants and reflexes saying just how they differ, what sources of confusion are and reasons of making the distinctions. The actual facts the student analyzes might be very similar in the two cases, the differences being mainly in what kind of study behavior the student engages in about them. The study questions were numerous enough so that there was a point to point relation between small parts of the text and a study question. The study questions, like the chapter sub-divisions, defined small unit of the text. The unit of text defined by a study question varied from several sentences to several paragraphs. Like the interview, each study question served as a conditioned reinforcer for the part of the text it defined and contributed to the reactivity of the study experience.

Abstract thinking was developed first by teaching the student the component performances and then rearranging them under the control of general statements. Thus, when the concept of chaining is introduced in Chapter 7, the student can already speak fluently about many sequences of performances and stimuli. For example, he can describe a pigeon pecking a key as a sequence in which only pecks of a certain form are followed instantly by a stimulus. Why it is necessary for the stimulus to follow the exact performance which is to be reinforced. In the presence of these stimuli (the food magazine sound and light) moving the head down to the feeder put the bird in the front of a hopper of grain so he can eat. In the absence of these stimuli, lowering the head does not have these consequences. When the student can describe these and other similar sequences of performances and stimuli, new verbal stimuli such as "a chain," "conditioned reinforcer" and "discriminative stimulus" are introduced and the existing verbal repertoire is brought under their control

by rearrangements appropriate to the concepts. In other words, the direct objective description of the behavioral events in plain English precedes the description of these same events in technical language. Theory is introduced even later, after the student has fluent control of the technical terms. A theoretical article by Skinner (1953) in Chapter 13, for example, was designed as a reinforcer for all of the chapters that preceded. The student could read such a chapter easily and meaningfully because he had already acquired all of the component behaviors from the preceding chapters. The article, which would be very difficult for the beginner, was easy and familiar for a student who had been properly prepared by the preceding text. Such a way of developing abstract thinking is the reverse of the procedure of many texts which state a principle first and then generate a few examples to illustrate it.

Each part of the text was designed to reinforce the behavior developed from the parts that went before. This was done by carrying the repertoire from each chapter forward with increased levels of abstraction and interaction with other terms and concepts. The development of abstract terms in stages, as described above, contributed to the cumulative effect of the text in which the behavior that the student acquired in one chapter or section contributed to or even made possible this behavior in the text. Thus schedules of reinforcement from one chapter is a necessary repertoire for the chapters on stimulus control which describe procedures in which intermittent reinforcement is an important component.

Summary

The course which is described here reverses the usual role of the student and professor. The student, who in the conventional classroom listens to the professor speak, now becomes an active participant who demonstrates the competence he acquires from his study of the course materials. The professor instead of conveying the course content to the student by speaking to him, arranges a verbal environment that recognizes the student's achievement and is reactive to it.

Although it was not necessary to lecture to the students to convey the course content to them, a limited number of lectures proved to be useful as a model of the repertoire that the student is trying to achieve and as a way of exhibiting the professor's style. Experience in this course confirms F. S. Keller's (1968) observation that about four or five lectures of 20-40 minutes each is an optimal amount of exposure of the professor's repertoire. Testing has a role different from the traditional lecture-examination teaching environment. Instead of a small sample of the student's behavior designed to test differences among students, the student's repertoire is examined in detail and depth so that he may go on to a next part of the course when he achieves competence in an earlier part.

An important by-product of the experimental classroom was the positive identification it encouraged with the professor, the course assistants and the objectives of the instructional system. In such a course, the role of the professor is that of an ally who helps the student to master the content and concepts needed to certify him. Since the criterion for certifying the student

involves a single high level of quality it was seldom necessary to take disciplinary action and the occurrence of a low grade was the student's decision not the professor's. Informal contact with the teaching staff also contributed to students' positive identification with the course. Because the professor was not occupied during the class period conveying the content of the course, he was free for casual and informal interaction with the students during class. Many student contacts were with the course assistants but the professor was continuously present and there was ample opportunity for all students to ask questions or to chat informally. As a result there were very few visits to the professor's office despite an open door policy.

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